



(19)

Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 806 852 A3

(12)

EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
12.04.2000 Bulletin 2000/15

(51) Int. Cl.⁷: H04L 5/14, H04L 1/12,
H04L 25/03, H04L 27/26

(43) Date of publication A2:
12.11.1997 Bulletin 1997/46

(21) Application number: 97303071.1

(22) Date of filing: 06.05.1997

(84) Designated Contracting States:
DE FR GB IT NL

(30) Priority: 09.05.1996 US 645020
20.06.1996 US 667267

(71) Applicant:
TEXAS INSTRUMENTS INCORPORATED
Dallas, Texas 75243 (US)

(72) Inventors:

- Timm, William C.
McKinney, TX 75070 (US)
- Chen, Walter Y.
Plano, Texas 75025 (US)
- Frantz, Gene A.
Missouri City, Texas 77459 (US)
- Garcia, Domingo G.
Plano, Texas 75075 (US)

- Lu, Xiaolin
Plano, Texas 75024 (US)
- Mannerling, Dennis G.
Garland, TX 75040 (US)
- Polley, Michael O.
Garland, Texas 75044 (US)
- Riley, Terence J.
Rockwall, Texas 75087 (US)
- Shaver, Donald P.
Dallas, Texas 75287 (US)
- Wu, Song S.
Dallas, Texas 75243 (US)

(74) Representative: Holt, Michael
Texas Instruments Limited,
P.O. Box 5069
Northampton NN4 7ZE (GB)

(54) A multimode digital modem

(57) A modem that operates selectively in the voice-band frequency band and at higher frequency bands is provided. This modem supports multiple line codes, like DMT and CAP.

The modem uses a Digital Signal Processor (DSP), so that different existing ADSL line codes, such as Discrete MultiTone (DMT) and Carrierless AM/PM (CAP), can be implemented on the same hardware platform. The modem negotiates in real-time, for a desired line transmission rate to accommodate line condition and service-cost requirement.

The line code and rate negotiation process may be implemented at the beginning of each communication session through the exchange of tones between the modems. A four-step MDSL modem initialization process is provided for line code and rate compatibility.

A new synchronization startup procedure for CAP based MDSL modems is provided. The handshake protocol and receiver algorithm allow reliable modem synchronization over severely amplitude distorted channels such as standard telephone twisted-pair wire. The algorithm makes use of a short length sequence to train a

synchronizing equalizer at the receiver. After training to this sequence, a matched filter or correlator is used to detect the inverted sync sequence. The detection of the inverted sequence signals the start of the normal reference training of the CAP demodulation equalizers.

The MDSL line connection management process provides a simple, efficient, and flexible interface to manage the line connection between MDSL-C (MDSL in Central Office site) and MDSL-R (MDSL in resident site) in the telecommunication Wide Area Networking environment. An internal state machine in an MDSL modem records and monitors the line status and notifies the state change to the other MDSL and also the host processor. The protocol used for exchanging line connection management messages is a simplified Link Control Protocol (LCP) for MDSL.

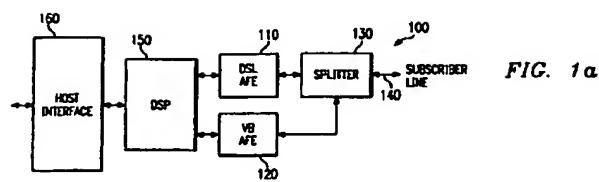


FIG. 1a



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 97 30 3071

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.)
X	WO 94 19877 A (ERICSSON TELEFON AB L M ; E SON AKERBERG DAG (SE); BERG PETRUS HUBE) 1 September 1994 (1994-09-01) * page 2, line 3 - page 3, line 25 * * page 4, line 26 - page 5, line 4 * * figures 1,2,4 *	1-3	H04L5/14 H04L1/12 H04L25/03 H04L27/26
X	JONES D L: "Fixed wireless access: a cost effective solution for local loop service in underserved areas" IEEE INTERNATIONAL CONFERENCE ON SELECTED TOPICS IN WIRELESS COMMUNICATIONS, 25 - 26 June 1992, pages 240-244, XP002107720 New York, NY, USA * abstract * * section 1.0 * * section 3.3 * * section 4.1, 4.3-4.4 * * figures 1,2 *	1-3	
X	EP 0 621 708 A (IBM) 26 October 1994 (1994-10-26) * page 5, line 4 - line 29 * * figure 1 *	1-3	
X	US 5 371 734 A (FISCHER MICHAEL A) 6 December 1994 (1994-12-06) * column 1, line 17 - line 22 * * column 5, line 9 - column 6, line 62 * * column 7, line 67 - column 8, line 36 * * figure 1 *	1-3	TECHNICAL FIELDS SEARCHED (Int.Cl.) H04Q H04L G06F H04M
X	US 5 475 735 A (LODWIG JOHN P ET AL) 12 December 1995 (1995-12-12) * column 3, line 47 - column 4, line 38 * * column 6, line 28 - line 41 * * figure 1 *	1-3	
		-/-	
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	7 February 2000	De Riccardis, F	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone	T : theory or principle underlying the invention		
Y : particularly relevant if combined with another document of the same category	E : earlier patent document, but published on, or after the filing date		
A : technological background	D : document cited in the application		
O : non-written disclosure	L : document cited for other reasons		
P : Intermediate document	& : member of the same patent family, corresponding document		



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 30 3071

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.)
X	EP 0 180 066 A (UNIVERSAL DATA SYSTEMS INC) 7 May 1986 (1986-05-07) * page 4, line 1 - line 21 * * page 5, line 17 - last line * * page 6, line 19 - last line * * page 7, line 7 - line 11 * * figures 1,3 *	5-8	
X	US 4 995 057 A (CHUNG HONG Y) 19 February 1991 (1991-02-19) * column 2, line 57 - column 3, line 5 * * column 5, line 19 - column 8, line 45 * * figures 1,3,4 *	5-8	
X	CROCHIERE R E, RABINER L R: "Multirate digital signal processing" 1983 , PRENTICE-HALL , ENGLEWOOD CLIFFS, NJ, USA XP002127495 * section 2.4.2 * * figures 2.19-2.22 *	9,10	
X	EP 0 599 315 A (SONY CORP) 1 June 1994 (1994-06-01) * page 3, line 24 - page 4, line 9 * * figure 1 *	11,12	TECHNICAL FIELDS SEARCHED (Int.Cl.)
X	EP 0 653 873 A (AT & T CORP) 17 May 1995 (1995-05-17) * column 1, line 57 - column 2, line 16 * * figures 4,7-10 *	13-15	
X	EP 0 706 278 A (AT & T CORP) 10 April 1996 (1996-04-10) * abstract * * column 1, line 55 - column 2, line 7 * * column 3, line 47 - column 4, line 1 * * column 4, line 22 - line 48 * -	16 -/-	
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		7 February 2000	De Riccardis, F
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 97 30 3071

DOCUMENTS CONSIDERED TO BE RELEVANT					
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.)		
X	US 5 388 150 A (SCHNEYER ROBIN ET AL) 7 February 1995 (1995-02-07) * column 7, line 42 - column 8, line 31 * * column 9, line 4 - line 27 * * column 10, line 45 - line 60 * * column 14, line 55 - column 15, line 8 * * column 16, line 21 - line 36 * * claim 18 *	17			
X	US 5 200 994 A (TSUKAMOTO AKIHITO ET AL) 6 April 1993 (1993-04-06) * column 1, line 48 - column 2, line 31 * * figures 8,9,12 *	18			
X	ITU: "Recommendation V.17: A 2-wire modem for facsimile applications with rates up to 14400 bit/s" CCITT, - February 1991 (1991-02) XP002129935 Geneva, CH * section 1 * * section 3 * * section 5 *	19,20, 24,26			
Y		21,27	TECHNICAL FIELDS SEARCHED (Int.Cl.)		
X	"AMERICAN NATIONAL STANDARD FOR TELECOMMUNICATIONS - NETWORK AND CUSTOMER INSTALLATION INTERFACES - ASYMMETRIC DIGITAL SUBSCRIBER LINE (ADSL) METALLIC INTERFACE", ANSI XP000196972 * section 12.1.1 * * sections 13.2.3-7 * * section G.2 *	28			
Y		22,23			
		-/-			
The present search report has been drawn up for all claims					
Place of search	Date of compilation of the search	Examiner			
THE HAGUE	7 February 2000	De Riccardis, F			
CATEGORY OF CITED DOCUMENTS					
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : Intermediate document					
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document					



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 30 3071

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.)
X	EP 0 632 629 A (MULTI TECH SYSTEMS INC) 4 January 1995 (1995-01-04) * page 2, line 26 - line 35 * * page 6, line 25 - page 7, line 1 *	30	
P,X	EP 0 719 062 A (AT & T CORP) 26 June 1996 (1996-06-26) * column 1, line 5 - column 2, line 35 * * column 3, line 5 - column 4, line 53 * * column 10, line 7 - column 11, line 14 * * figures 1,2 *	1-4	
P,X	US 5 544 223 A (ROBBINS BARRY R ET AL) 6 August 1996 (1996-08-06) * column 4, line 66 - column 5, line 35 * * figure 1 *	1-3	
P,X	CHEN W Y: "A DIRECT EQUALIZATION METHOD" IEEE INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING (ICASSP), vol. 3, 21 - 24 April 1997, pages 2505-2508, XP000735068 ISBN: 0-8186-7919-0 * abstract * * sections 4,5 * * figures 6,7 *	5-8	TECHNICAL FIELDS SEARCHED (Int.Cl.)
Y	LIN D W ET AL: "VIDEO ON PHONE LINES: TECHNOLOGY AND APPLICATIONS" PROCEEDINGS OF THE IEEE, US, IEEE, NEW YORK, vol. 83, no. 2, page 175-192 XP000501240 ISSN: 0018-9219 * page 183 *	13-15	
Y	US 4 757 495 A (HUGHES-HARTOGS DIRK ET AL) 12 July 1988 (1988-07-12) * column 2, line 55 - column 5, line 28 * * column 7, line 19 - column 8, line 48 *	13-15,25	
-/-			
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	7 February 2000	De Riccardis, F	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : Intermediate document			



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 97 30 3071

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CI)
Y	US 4 931 250 A (GRESZCZUK JOHN A) 5 June 1990 (1990-06-05) * column 1, line 43 - column 2, line 2 *	13-15	
Y	WO 91 00655 A (MOTOROLA INC) 10 January 1991 (1991-01-10) * page 2, line 23 - page 3, line 3 *	21,25	
Y	WO 95 34149 A (AMATI COMMUNICATIONS INC ;CIOFFI JOHN M (US); BINGHAM JOHN (US); J) 14 December 1995 (1995-12-14) * page 22, line 14 - line 32 * * page 24, line 24 - page 25, line 2 * * page 28, line 18 - line 32 *	22,23,25	
Y	US 3 875 515 A (STUART RICHARD L ET AL) 1 April 1975 (1975-04-01) * column 1, line 21 - column 2, line 31 *	27	
E	US 5 812 786 A (SISTANIZADEH KAMRAN ET AL) 22 September 1998 (1998-09-22) * abstract * * column 3, line 43 - line 51 * * figures *	13-15,30	TECHNICAL FIELDS SEARCHED (Int.CI)
A	US 5 479 447 A (CIOFFI JOHN M ET AL) 26 December 1995 (1995-12-26) * column 5, line 26 - column 6, line 19 * * figures 1,2,5 *	13-15	
A	US 5 369 682 A (WITSAMAN MARK L ET AL) 29 November 1994 (1994-11-29) * the whole document *	16	
A	US 5 323 444 A (NEAL LISA M ET AL) 21 June 1994 (1994-06-21) * the whole document *	17	
		-/-	
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	7 February 2000	De Riccardis, F	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 97 30 3071

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.CI6)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	<p>DATABASE TDB 'Online! January 1982 (1982-01) "Word Processing Display Unit with Means for Indicating Communications Status" XP002129936 * abstract *</p> <hr/> <p>EP 0 624 033 A (KONINKL PHILIPS ELECTRONICS NV) 9 November 1994 (1994-11-09) * column 8, line 52 – column 9, line 11 *</p> <hr/>	17	
		29	
			TECHNICAL FIELDS SEARCHED (Int.CI6)
<p>The present search report has been drawn up for all claims</p>			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	7 February 2000	De Riccardis, F	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			



European Patent
Office

Application Number
EP 97 30 3071

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

- No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

- As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

- Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

- None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-4

Wireless point-to-multipoint distribution system

2. Claims: 5-8

Equalizer for dual channel communication

3. Claims: 9-10

DSL modulation and demodulation

4. Claims: 11-12

Multistage modulation and demodulation with variable scaling

5. Claims: 13-15

Multimode modem

6. Claim : 16

Multi-link modem

7. Claim : 17

Link connection management process

8. Claim : 18

Modem identification method

9. Claims: 19-23 25-26

Rate negotiation process

10. Claim : 24 27

Modem initial synchronization

11. Claim : 28



European Patent
Office

**LACK OF UNITY OF INVENTION
SHEET B**

Application Number
EP 97 30 3071

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

Video conferencing

12. Claim : 29

Interfacing modem hardware with a host operating system

13. Claim : 30

Modem upgrade

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 97 30 3071

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-02-2000

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
WO 9419877	A	01-09-1994		AU 679960 B AU 5825294 A BR 9306259 A CA 2133735 A CN 1108450 A EP 0636290 A FI 944845 A JP 8507183 T MX 9400872 A NO 943926 A NZ 259444 A SE 9300495 A SG 49789 A US 5533027 A	17-07-1997 14-09-1994 30-06-1998 17-08-1994 13-09-1995 01-02-1995 14-10-1994 30-07-1996 31-08-1994 17-10-1994 24-06-1997 17-08-1994 15-06-1998 02-07-1996
EP 0621708	A	26-10-1994		US 5384777 A BR 9401518 A CA 2115211 A,C CN 1100857 A JP 2662181 B JP 7015433 A KR 138001 B	24-01-1995 27-12-1994 20-10-1994 29-03-1995 08-10-1997 17-01-1995 01-07-1998
US 5371734	A	06-12-1994		AU 6097594 A CA 2154897 A EP 0681763 A WO 9417606 A	15-08-1994 04-08-1994 15-11-1995 04-08-1994
US 5475735	A	12-12-1995		AU 1045295 A CA 2153249 A EP 0682845 A FI 953691 A JP 8506471 T WO 9515664 A	19-06-1995 08-06-1995 22-11-1995 21-09-1995 09-07-1996 08-06-1995
EP 0180066	A	07-05-1986		AU 4847585 A JP 61181224 A NO 853772 A	08-05-1986 13-08-1986 05-05-1986
US 4995057	A	19-02-1991		FR 2639493 A GB 2225199 A,B GB 2262866 A,B GB 2262867 A,B JP 2172333 A	25-05-1990 23-05-1990 30-06-1993 30-06-1993 03-07-1990
EP 0599315	A	01-06-1994		JP 6164414 A	10-06-1994

EPO FORM P059
For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 97 30 3071

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-02-2000

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
EP 0599315	A		US	5454011 A	26-09-1995
EP 0653873	A	17-05-1995	US	5475691 A	12-12-1995
			CA	2132643 A	16-05-1995
			CN	1117228 A	21-02-1996
			IL	111619 A	30-09-1997
			JP	7193660 A	28-07-1995
EP 0706278	A	10-04-1996	US	5588051 A	24-12-1996
			AU	700035 B	17-12-1998
			AU	3300995 A	18-04-1996
			CA	2156755 A,C	06-04-1996
			JP	8274885 A	18-10-1996
US 5388150	A	07-02-1995		NONE	
US 5200994	A	06-04-1993	JP	2051937 A	21-02-1990
			JP	2656309 B	24-09-1997
			JP	2111143 A	24-04-1990
			CA	1315428 A	30-03-1993
			US	5220599 A	15-06-1993
EP 0632629	A	04-01-1995	CA	2126926 A	03-01-1995
			JP	7147611 A	06-06-1995
			US	5644594 A	01-07-1997
EP 0719062	A	26-06-1996	US	5592470 A	07-01-1997
			JP	8280058 A	22-10-1996
US 5544223	A	06-08-1996	AU	4776396 A	21-08-1996
			BR	9607165 A	11-11-1997
			CN	1172572 A	04-02-1998
			EP	0807364 A	19-11-1997
			JP	10513620 T	22-12-1998
			WO	9624232 A	08-08-1996
			ZA	9600226 A	09-07-1996
US 4757495	A	12-07-1988	GB	2187611 A,B	09-09-1987
			JP	63272151 A	09-11-1988
US 4931250	A	05-06-1990	CA	1331648 A	23-08-1994
			DE	68925815 D	04-04-1996
			DE	68925815 T	10-10-1996
			EP	0416013 A	13-03-1991
			HK	1009320 A	28-05-1999
			JP	3505272 T	14-11-1991

FORM P048

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 97 30 3071

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-02-2000

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 4931250 A		WO	8911183 A	16-11-1989
WO 9100655 A	10-01-1991	CA	2050892 A	27-12-1990
		CN	1049588 A	27-02-1991
WO 9534149 A	14-12-1995	US	5625651 A	29-04-1997
		US	5644573 A	01-07-1997
		US	5557612 A	17-09-1996
		AU	695092 B	06-08-1998
		AU	2696295 A	04-01-1996
		AU	8946798 A	07-01-1999
		CA	2191437 A	14-12-1995
		EP	0763295 A	19-03-1997
		FI	964805 A	14-01-1997
		JP	10503893 T	07-04-1998
		US	5933454 A	03-08-1996
US 3875515 A	01-04-1975	NONE		
US 5812786 A	22-09-1998	NONE		
US 5479447 A	26-12-1995	NONE		
US 5369682 A	29-11-1994	US	5365569 A	15-11-1994
		AU	5012293 A	15-03-1994
		CA	2142730 A	03-03-1994
		CN	1088036 A	15-06-1994
		EP	0655180 A	31-05-1995
		FI	950662 A	31-03-1995
		WO	9405110 A	03-03-1994
US 5323444 A	21-06-1994	NONE		
EP 0624033 A	09-11-1994	FI	942110 A	08-11-1994
		JP	7075099 A	17-03-1995
		US	5440347 A	08-08-1995
		US	5565926 A	15-10-1996
		US	5561468 A	01-10-1996
		US	5619534 A	08-04-1997